STATEMENT OF DENNIS SPURGEON

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BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

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Senator Craig, Chairman Domenici, Senator Bingaman, and Members of the Committee, it is a pleasure for me to be here today to discuss the Administration's progress in implementing Subtitle C, Sections 641 through 645 of the Energy Policy Act of 2005 (EPACT 2005) pertaining to the Next Generation Nuclear Plant (NGNP).

I would like to thank the committee for its leadership in encouraging the Department to pursue the use of clean, abundant and affordable nuclear energy to meet not just demand for electricity, but our future needs for clean, emissions-free, efficient process heat for hydrogen production and other energy uses.

EPACT 2005 Sections 641 through 645 establish expectations for research, development, design, construction, and operation of a prototype nuclear plant which will provide electricity and/or hydrogen. This plant will include a nuclear reactor based on research and development activities supported by the Generation IV Nuclear Energy Systems Initiative.

These provisions establish two distinct phases for the project. In Phase I, to be completed by 2011, DOE is directed to select the hydrogen production technology and develop initial reactor design parameters for use in Phase II. Phase I is the research and planning part of the initiative and it is the phase in which the Department is currently engaged. As contemplated in Phase II, the Department would complete the design and construction of a prototype plant at the Idaho National Laboratory by 2021. EPACT 2005 also establishes expectations for NGNP program execution, including industry participation and cost-share, international collaboration, Nuclear Regulatory Commission (NRC) licensing, and review by the Nuclear Energy Research Advisory Committee.

As I indicated at my confirmation hearing, I recognize the NGNP is an important priority for Senator Craig and this committee and Congress as a whole. Shortly after being sworn in as Assistant Secretary, I traveled to the Idaho National Laboratory, the lead laboratory for development of the NGNP, to meet with laboratory officials on the research program, to better understand the work that has been accomplished to date and to better understand the laboratory's detailed plans to meet the expectations set by EPACT 2005.

Over the last four years, through the *Generation IV* initiative and the *Nuclear Hydrogen Initiative*, which is part of the President's Hydrogen Fuel Initiative, the Department has conducted a research and development program for a very high temperature gas-cooled nuclear system with the capability to produce hydrogen and/or electricity. The Nuclear Hydrogen Initiative is broadly aimed at developing hydrogen production technologies that can be coupled with nuclear systems, including a very high temperature reactor as contemplated in EPACT 2005. The efforts pursuant to EPACT 2005 ongoing today consist of research and development on a reactor and the coupling of the reactor to a hydrogen production system. More than $120 million has been expended by DOE on the NGNP and Nuclear Hydrogen initiatives since fiscal year 2003. The Department has requested more than $42 million in fiscal year 2007 for NGNP research and development and the Nuclear Hydrogen Initiative.

With the enactment of EPACT 2005, the efforts over the next several years will be focused on the research, development, establishment of initial design parameters, functional requirements, a licensing strategy, and other activities necessary to complete the Phase I scope of work. Where possible, we are collaborating with our international partners via the Generation IV International Forum to maximize the value of our R&D investments and minimize duplication of efforts.

Much of the current reactor development effort is aimed at developing a high burn-up particle fuel. The fuel development effort builds on the prior successful efforts by the U.S. and international research community with gas-cooled reactors and coated particle fuel development.

To support the completion of Phase I in 2011, work is progressing in developing design data needs for key components of the reactor heat transport and other major systems. In particular, we are working to qualify materials for use in the high temperature and high radiation environment of the NGNP. Significant efforts are also underway to develop and demonstrate at the laboratory scale, high temperature technologies capable of converting process heat from a nuclear reactor to hydrogen.

This year, we will begin working in earnest with the Nuclear Regulatory Commission (NRC) to develop a licensing strategy for the technology, which pursuant to EPACT 2005 must be submitted to Congress by August 8, 2008. Licensing a prototype reactor by the NRC and obtaining certification of the nuclear system design will present a significant challenge and may be very difficult to accomplish in the timeframe contemplated. It is likely that, at the same time we are seeking a license for a first-of-a-kind reactor, the NRC may receive twelve Construction and Operating License applications to build approximately 21 new nuclear plants. This estimate may change with time. While the focus of the Office of Nuclear Energy is on renewed deployment of commercial reactors, it is important that we begin discussions with NRC as early as possible on the licensing strategy and associated staffing resources.

My prior professional experience with commercial-scale gas-cooled reactors in the U.S. suggests that to be successful in developing an economic and efficient reactor that can produce higher temperature process heat (on the order of 850-950 degrees centigrade) than current generation light water reactors, and successful in moving the technology to the market, we need to bring the end users into the initiative at the earliest possible time – the petrochemical industry, the chemical processing industry, the manufacturing industry, and electric utilities. I firmly believe that those entities that will directly benefit from the technologies must drive the technology requirements.

I also believe that we need to focus the NGNP effort on determining if there are more near-term approaches that would lead to earlier commercialization, within the planning horizon of industry. My objective would be to establish a public-private partnership with end users to complete the development of technologies and do so early, allowing the technology to be moved to the market sooner. The Nuclear Energy Research Advisory

Committee reached similar conclusions in its assessment of the NGNP Program Plan that was required by EPACT 2005 and delivered on schedule to Congress in April 2006.

I applaud the efforts of Senator Craig and this committee in this regard, as expressed in EPACT 2005 and I thank Senator Craig for holding this hearing. I intend to build on current efforts to work with the Idaho National Laboratory to bring end users into this initiative. As an initial step, this fall, my office and the Office of Energy Efficiency and Renewable Energy, which leads the President's Hydrogen Fuel Initiative, will sponsor a workshop with end users to focus on the functional requirements for production of process heat from nuclear reactor technology.

More information concerning the Department's ongoing research and development effort is summarized below in context of research elements that are identified in EPACT 2005: high temperature hydrogen production technology, energy conversion technology development and validation; nuclear fuel development, characterization and qualification; materials selection, development, testing and qualification; reactor and balance-of-plant design; and engineering, safety analysis and qualification. As discussed above, the Department is making good progress. Completing the research and development is critical to proceeding to the next phase of the initiative, detailed design and construction.

BACKGROUND

In 2001, the Department led an international effort to develop a roadmap for the next generation of nuclear energy systems. This roadmap, published in December of 2002, identified the six most promising Generation IV reactor systems for international development. Of these six systems, the United States placed early emphasis on the very high temperature gas-cooled reactor concept – also referred to as the Next Generation Nuclear Plant -- because of its potential for enhanced safety and economical production of process heat that could be used for various energy products, *e.g.*, hydrogen, electricity, and process heat for manufacturing.

For a hydrogen end use, the Department has for the last few years, pursued the development of a range of high temperature hydrogen production technologies. We are presently conducting or planning for integrated laboratory-scale demonstrations for two such technologies – sulfur-iodine and high temperature electrolysis. While EPACT 2005 would require us to choose a single technology for hydrogen production by 2011, at this time we believe both technologies merit development support and in fact require it to prove economic and technical feasibility. We feel we can economically support multiple technology success paths and meet our overall requirement for demonstrating nuclear hydrogen production as part of NGNP.

Development of the very high temperature gas-cooled reactor is part of a broader international effort to cooperate on the development of the next generation of reactor technologies – technologies that are safer, more proliferation resistant, sustainable, and less waste intensive than current generation technologies. Under the Generation IV International Forum or GIF, ten nations and the European Union collaborate in the development of the six promising technologies identified in the Generation IV Roadmap. One of these six is the very high temperature gas-cooled reactor. Also of interest to the U.S. is the sodium-cooled fast reactor for its ability to help close the fuel cycle. International interest in the very high temperature gas-cooled reactor is high among the GIF member nations. GIF member nations are currently establishing bi-lateral and multi-lateral agreements for cooperation on those technologies that each country is interested in pursuing, including the very high temperature reactor. France, Japan, and South Africa are among the GIF countries interested in the very high temperature reactor.

The very high temperature gas-cooled reactor concept that we are investigating through the NGNP is a helium-cooled, graphite-moderated, thermal neutron spectrum reactor. Of the six Generation IV technologies, the GIF judged it to be the most promising concept for an economically competitive nuclear heat source. In order to produce process heat of sufficiently high temperature needed for use in producing other energy products such as hydrogen, the Department believes the reactor outlet temperature would need to be in the range of 850 degrees centigrade to 950 degrees centigrade. This is a key consideration in the design and performance of the reactor.

The reactor core would be either a prismatic block or pebble bed concept. The reactor could produce both electricity and hydrogen using an indirect cycle with an intermediate heat exchanger to transfer the heat to either a hydrogen production facility or a gas turbine. The basic technology builds on the Fort St. Vrain and Peach Bottom Unit 1 reactor work. Presently, a pebble bed reactor with characteristics consistent with the very high temperature gas-cooled reactor design goals is in commercial development in South Africa with construction set to commence next year, as you will hear today in testimony from Mr. Regis Matzie.

HIGH TEMPERATURE HYDROGEN PRODUCTION TECHNOLOGY

The development of a portfolio of hydrogen production technologies, including nuclear energy technologies, is an important component of strengthening the United States' energy, economic, and national security. The Department has defined an aggressive path to demonstrate hydrogen production from nuclear energy by the end of the next decade. The technical challenges to achieving this goal are significant, but the development of emission-free hydrogen production technologies is an important component of the long-term viability of a hydrogen economy.

Nuclear energy has the potential to play a major role in assuring a secure and environmentally sound source of transportation fuels. The fundamental challenge is to focus finite research resources on those processes which have the highest probability of producing hydrogen at costs that are competitive with gasoline. Both thermochemical and high-temperature electrolysis methods have the potential to achieve this objective. Small-scale experiments have operated successfully to date and show promise for integrated laboratory and other larger-scale system demonstrations.

We are building a basis for making research and development funding decisions by conducting a research effort involving laboratory-scale demonstrations and analytical evaluations. This will be followed by integrated laboratory-scale experiments to confirm technical viability and provide information needed to reach informed decisions on whether to conduct larger scale demonstrations. Pilot plant demonstrations of the selected processes would confirm engineering viability and establish a basis for process costs. We would propose to perform independent analyses of performance and costs to support the comparative assessments required for technology selection and scaling decisions, and establish effective interfaces with industry and international partners.

In fiscal year 2006, components for the two baseline thermochemical cycles (sulfur-iodine and hybrid sulfur) are being constructed and tested individually. In fiscal year 2007, components for the sulfur-iodine cycle will be brought together for integrated laboratory-scale experiments, and a laboratory-scale electrolyzer for the hybrid sulfur cycle will be designed and constructed.

In the area of high-temperature electrolysis, a successful bench-scale test of a 25-cell electrolyzer stack was completed in February 2006. This test produced over 100 liters per hour of hydrogen for 1,000 hours. A module is currently being constructed to examine multi-stack electrolysis operations, and in fiscal year 2007, the Department will complete construction of an integrated laboratory-scale experiment utilizing a 60-cell electrolyzer module.

In parallel with these activities in fiscal years 2006 and 2007, the Department continues to examine materials and components needed to interface the hydrogen production processes under development with the nuclear heat source, and to ensure that these materials and components withstand the nuclear heat and radiation environments.

By 2010, the Department anticipates completing integrated laboratory-scale experiments of thermochemical cycles and high-temperature electrolysis technologies for producing hydrogen to confirm technical feasibility of the closed loop processes. Results of these experiments will inform the selection of the high-temperature hydrogen production technology required by the EPACT 2005 by the end of fiscal year 2011. For the process or processes selected for further development, design activities will be initiated by 2011 for pilot-scale experiments at higher power levels to evaluate scalability of the processes for eventual commercial use.

NUCLEAR FUEL DEVELOPMENT, CHARACTERIZATION, AND QUALIFICATION

Advanced gas-cooled reactor fuel is being developed for use in the NGNP. This fuel development program is aimed at re-establishing the core capability for producing coated particle fuel in the United States. Fuel kernels are being manufactured by the BWXT Corporation in Lynchburg, Virginia, and coated at the Oak Ridge National Laboratory (ORNL).

Testing of the particles is slated to begin at the end of fiscal year 2006 at the Advanced Test Reactor (ATR) at the Idaho National Laboratory. This first test will shake-down the test equipment and generate useful data on four different coated particle fuel variants. There are eight in-reactor tests planned, with the final test to be completed in 2019. General Atomics of San Diego, California, the last gas reactor and fuel vendor in the United States (for the Fort St. Vrain reactor) is providing technical assistance. By 2011, we expect to complete the second and third irradiation campaigns that will test the fission product retention and performance of the fuel.

MATERIALS SELECTION, DEVELOPMENT, TESTING AND QUALIFICATION

This work involves the identification and qualification of suitable materials for use in the high temperature and high radiation environment of the NGNP system and components.

Nuclear-grade graphite suitable for NGNP has been identified and specimen procurement is underway. Experiment design for creep-irradiation testing using the ATR will be completed in fiscal year 2006. ATR irradiations are anticipated to begin in late fiscal year 2007. We will also begin the irradiation of South African graphite samples in the ORNL High Flux Irradiation Reactor early next fiscal year.

Materials for use in the intermediate heat exchanger have been selected and are being procured. The intermediate heat exchanger isolates the reactor coolant from the secondary working fluid needed for process heat industrial applications or electricity production. Aging and mechanical testing of material specimens is ongoing. Code qualification work has been initiated with the American Society of Mechanical Engineers. Research on suitability of ceramics and composites for use in safety and control rods in the reactor core is ongoing. The development of codes and standards for these ceramics is being explored.

REACTOR AND BALANCE-OF-PLANT DESIGN, ENGINEERING, SAFETY ANALYSIS AND QUALIFICATION

Design studies are being performed to inform the direction of research and development in materials, fuel development and codes and methods. Design studies have been completed for both prismatic core and pebble bed gas-cooled reactors. Trade studies specific to various components are underway, including the reactor vessel and the intermediate heat exchanger. Prior to 2011, a detailed specification for the NGNP will be developed for inclusion in the Request for Proposals for NGNP design.

For design, safety analysis and qualification, there is a need to modernize analytical codes and methods to reduce uncertainty and enhance safety in the NGNP design. This research focuses on defining the margin that exists between the limiting or design values versus the calculated results for any operating scenario. Work is underway on the modeling and codes associated with the reactor physics and thermal-hydraulics. A test plan is being developed to use the Argonne National Laboratory Natural Convection Shutdown Heat Removal Test Facility to obtain experimental data to analyze how to provide cooling for the reactor vessel under postulated accident conditions. Testing is also underway to validate computer models associated with computational fluid dynamics. An international standard problem set for code verification and analysis is expected to be assembled by 2011.

ENERGY CONVERSION TECHNOLOGY DEVELOPMENT AND VALIDATION

The current energy conversion research activity is a relatively small effort at this time and is aimed at aligning reactor output with the most appropriate power conversion system to optimize the electrical output at the highest efficiency and lowest cost. Presently, the Department's efforts are focused on conducting engineering and comparative studies to ascertain the pros and cons of various designs. This area will receive greater attention from the reactor vendors as the NGNP program moves forward with design activities in 2011.

CONCLUSION

The Department is making steady progress toward meeting the requirements established by EPACT 2005, but there is clearly significant work to be done. The NGNP target dates present some schedule risk for the Department, especially in light of the challenges involved in certifying a new reactor technology.

If these or other hydrogen-producing technologies when coupled with the very high temperature reactor or even more conventional reactors can be proven to produce hydrogen at a cost of $3.00 per gallon of gasoline equivalent, delivered and untaxed, or less, I believe we will have nuclear technologies that are economic and viable for commercialization. The key to our success will be our ability to draw the end users into the initiative and our ability to effectively address the regulatory process.

Again, I would like to thank Senator Craig for holding this hearing and in particular, for bringing the perspective of end users to this important discussion. I would be pleased to answer your questions.